**Quiz 1 – 2.75–2012, October 2, 2012**

Name: __________________________________________________________

*Please do your work in the exam book.*

**Problem 1 (60 Points):**

You are hired by *PressThemApples* to design a powered apple cider maker, for home use, that extracts the juice from apples by squeezing them.

One *Strategy* is a powered version of a traditional press where a plate moves down inside a barrel to squeeze the apples and force the juice out through slits and holes in the barrel. A simple up-down control will be implemented: When the user presses the “up” button, the press plate lifts to allow loading of apples in the press. Then when the user presses the “down” button, the press plate lowers and squeezes the apples to extract juice, holding the force until juice has stopped flowing.

A. Consider the governing physics of the problem. What are the important parameters/quantities to consider in this design? Suggest approximate values to use in your calculations. (10 pts)

B. Present at least two mechanical Concepts (clearly labeled sketches) for the given press strategy, pick your top concept and, with a simple bulleted list, explain why you chose it. (25 pts)

C. Using first-order engineering calculations (appropriate analysis) to determine if your concept is feasible or not. (If not feasible, don’t worry, but then suggest alternatives). (25 pts)

**Problem 2 (40 Points):**

In this problem you are asked to design the various circuit blocks of the ECG system shown in the Figure below: a 1.5V voltage source, a resistor programmable gain stage, a low pass filter and an output stage to drive a 50ohm scope probe.

The peak-to-peak ECG signal at the electrodes is between 0.1mV and 10mV and can be positive or negative depending on the vector being measured. The instrumentation amplifier is powered by a single 3V supply and has a gain of 100. The output of the instrumentation amplifier has a DC voltage of 1.5V with an ECG peak-to-peak voltage between 10mV and 1V. Note the ECG voltage may be above or below 1.5V depending on the probe placement but the total output voltage is always between the rails. A 1.5V DC voltage source provides the signal ground and drives the body to the same potential.
For this design you are given a kit with several 1Kohm and 10Kohm resistors and a capacitor with a value of your choice. You are also given “ideal” opamps powered with a single 3V supply. Choose the appropriate configuration from the three shown below and modify with other components in your kit as appropriate for your design.

A. Design a 1.5V voltage source using resistors and an opamp from the configurations above for the “driven right leg” and to provide the reference voltage for the instrumentation amplifier. Draw the circuit and label the resistor values. (10 pts)

B. Design a gain stage using resistors and an opamp from the configurations above as well as a switch. The switch should toggle the gain to be 1 or 10 so that the output peak-to-peak ECG voltage is between 0.1V and 1V depending on which resistor is switched in. Draw the circuit and label the resistor values. Explain in one sentence why you chose the particular configuration. (10 pts)

C. Design a low pass filter that has a pole at 2\pi f = 1kHz. Consider the circuit topology so that the time constant is accurate. Draw the circuit and label resistor and capacitor values. Explain in a one sentence why you chose the particular circuit topology. (10 pts)

D. Draw a circuit diagram for the final stage to communicate the output signal of the filter to the 50ohm scope probe without affecting the characteristics of the filter. Label any passive components that you use. (10 pts)